SOME OBSERVATIONS ON SUN-BATHING IN BIRDS

BY DORIS C. HAUSER

THE effect of the sun on passerines and other terrestrial birds is a subject about which little has been written. Voluntary sun-bathing, accompanied by preening, surely has been observed widely but the details seldom have been recorded for the benefit of those interested in all phases of bird behavior. Therefore, it seems worthwhile to report my observations of sunning behavior which have been gathered over a number of years.

From the end of March, 1954, until August 20, 1954, in Gainesville, Florida, and thereafter at Fayetteville, North Carolina, I have observed and recorded in sun-bathing attitudes, hundreds of individual birds of 33 different species. These records suggest that there are two reasons for the assumption of the characteristic posture:

1. Voluntary, or normal sun-bathing; an attitude assumed by a bird apparently for reasons of health and well-being, accompanied by preening, shaking, scratching and repeated resumption of the sun-bathing posture.
2. Compulsory Sun Position, the same attitude assumed when a bird is suddenly and apparently unexpectedly exposed to direct sunlight, under more or less extreme conditions of humidity and heat. This response may be accentuated by the physiological condition of the bird; and it appears to be unpremeditated and irresistible. Upon recovery the bird usually flies immediately to shade.

Voluntary Sun-bathing in Songbirds

On April 17, 1952, I saw a Brown Thrasher (*Toxostoma rufum*), in full sun, deep in the soft, dry sand of our driveway in Gainesville, Florida. Breathing heavily, with its bill wide open, the bird's head had fallen back as though it were suffering and dying. The body feathers were ruffled and the tail and wings spread into full fans, but as I approached closer the thrasher recovered completely and flew into the brush.

Since witnessing that incident, I have seen birds sun-bathing from Maine to Texas and, although some species differ slightly in their posture, the general pattern is much the same.

It is recognized that many birds expose themselves to the rays of the sun, fluffing out their feathers and leaning to one side, immobile, and then ruffling and preening. The specific good they derive from such behavior is not definitely known. It has been suggested that birds fluff their feathers to remove parasites by exposing them to the sun or to dust. Some authorities, notably Hou (1929, cited by Kendeigh, 1934) believe that there is a connection

between the use of the preen gland and the proper effect of irradiation. Dr. Herbert Friedmann wrote me (June, 1954) that he had experimented with the secretion of the preen gland: "The secretion, when rubbed on the feathers and subsequently exposed to sunlight and then inadvertently swallowed by the bird when preening its plumage, is a source of Vitamin D."

It appears, from my observations, that the previous weather conditions often have a great deal to do with sun-bathing. A rainy spell or several dark days, followed by strong sunlight appear to accelerate the need for the sun's rays and will bring many birds out to bask in the sun and to preen. However, Miller (1952) reported sun-bathing in House Finches (*Carpodacus mexicanus*) under conditions of low relative humidity and high summer temperature in California and my records include many incidents of voluntary sun-bathing in hot, dry periods.

In addition, it appears that there is a social quality in sun-bathing; that a single bird in the Voluntary Sun Position attracts the attention of other birds, which join the first and also sun-bathe. These may be of the same or of a different species. Another factor rests in the use of a particular site for repeated sun-bathing, day after day and month after month. In my yard in Florida during 1954 dozens of birds of different species sun-bathed in my pear tree; at present, in Fayetteville, North Carolina, a fallen but still verdant pecan tree is the community sun bath. When sunshine follows a heavy rain, I can see from 10 to 30 birds of six or more species sun-bathing in that single tree.

Young birds are seen sun-bathing more frequently than adults except during the late summer molting season when many adult birds in all stages of molt may be seen preening and sunning.

Sun-bathing patterns of some perching birds are described below:

At 1:20 p.m. on May 7, 1954, a female Cardinal (*Richmondena cardinalis*) was observed in full Sun Position on the ground. Its bill was slightly open, head and body at a 50-degree lean to the right, body feathers fully fluffed; then it leaned even further to the right. The bird changed its position from facing the sun to placing its left side to the sun. Preening briefly, the bird then flew to the pear tree after about five minutes in the sun.

The earliest morning record of voluntary sun-bathing was that of a female Cardinal in heavy molt at 7:30 a.m. on August 4, 1954. With only one full-length feather in its crest and three in its tail, the ragged-looking bird spent fully 15 minutes sun-bathing in the early morning sun. The bird first faced the sun and then turned with its back to the sun, assuming the full Sun Position after each lengthy period of preening during which it appeared to work its bill along every one of its feathers.

August 12, 1954, at 11:50 a.m., a young female White-eyed Towhee (*Pipilo erythrophthalmus*) came to the water pan to bathe fully with House Sparrows (*Passer domesticus*) three or four times. Then it flew to a spot on the ground, in full sun, beside the wax myrtle hedge. In company with six or eight sparrows, already in different stages of sun-bathing, the towhee preened, fluffed its feathers and shook its body for five minutes; then it settled low in a modified sun-bathing position with crown feathers raised, bill

open, and body and head leaning to one side but without the body feathers being fully fluffed. The bird alternately preened and resumed the sunning pose. A young Blue Jay (*Cyanocitta cristata*) flew down and settled by the towhee and assumed the sun-bathing position, with crest raised high, body feathers fully fluffed, and wings and tail fanned, leaning to one side with its bill open for 30 seconds, and then flew away. A second young jay dropped down for a brief sun bath with the sparrows and towhee. The sparrows were changing constantly, with new sun-bathers taking the places of those which left.

Of the order Piciformes, I have seen the Flicker (*Colaptes auratus*), the Red-bellied Woodpecker (*Centurus carolinus*) and the Golden-fronted Woodpecker (*C. aurifrons*) of Texas in sun-bathing attitudes. The latter two birds use telephone poles as well as trees in full sun for their sun-bathing perches.

April 25, 1954, at 9.00 a.m., a Red-bellied Woodpecker was making loud "kraaaak" calls from the top of a telephone pole. After three or four calls, it would preen and ruffle its feathers and call again. The bird repeatedly pecked into the top of the post, digging its bill then into its feathers all over its body and wings, back and front. Then it waddled over 12 inches to the top of the cross-bar of the pole where it continued to preen and call and stretch its wings. Next the bird spread itself out into full Sun Position, with crown feathers raised, head cocked to one side, bill open, with the upper eye staring at the sun. Staying thus only briefly, the woodpecker would get up to preen, stretch, call, and change position on the cross-bar, probably half a dozen times. At one change, the bird straddled the cross-bar with its wings hanging down at either side, full fanned, and its tail spread wide and the crown feathers raised.

The Ground Dove (*Columbigallina passerina*) differed from most species in that it never leaned far to one side nor opened its bill, despite the length of its stay in the full sun; and it also was the only bird which blinked its eyes throughout the sunbath.

May 1, 1954, at 11:30 a.m., a Ground Dove sun-bathed at what later proved to be a favorite spot, on a heap of drying magnolia leaves. The bird preened lengthily with its rump feathers raised high while preening the wings. Turning to face different directions after each brief period of preening and sunning, it spread its wings and made a partial fan of its tail and, raising the crown and body feathers, stood immobile but still blinking. The dove's sunbath lasted for 15 minutes.

The month of June, 1955, in Fayetteville, had been extraordinarily cool, rainy and overcast, with only a few hot days and very little sun. On June 25, a day with moderate to fresh breezes and an air temperature of 90° F., I verified the site of a second sun-bathing location, having earlier seen many species flying into this place. The site was a compost heap, primarily composed of decaying elm leaves, in a corner of the yard just below the fallen pecan mentioned earlier, and well secluded by shrubs and high grasses. No birds were sun-bathing on the pecan, probably because of the breezes. Onto this heap, from 1:30 to 3:00 p.m., when the sun was free of the drifting clouds, I watched three Crested Flycatchers (*Myiarchus crinitus*), two Tufted Titmice (*Parus bicolor*), three Blue Jays, Catbirds (*Dumetella carolinensis*), Cardinals and House Sparrows approach via a perch on the pecan tree, then

onto the fence, and finally down to the leaf bed. Here they immediately assumed the Voluntary Sun Position, and in each of the birds, the attitude was so exaggerated that I returned to the house for a Taylor candy thermometer, which registered 140° F. when laid on the leaf bed in the full sun.

None of the birds preened at this site but, having exposed themselves to the sun for one to three minutes, they flew to shade with bills still open, panting. I believe that some, if not all, flew down to bathe at the creek after the sunbath, but heavy brush made it impossible to follow any individual bird with my glasses although the creek is not over 40 feet from the leaf bed.

Figure 1 (inset 6) illustrates a Mockingbird (*Mimus polyglottos*) in an exaggerated sun-bathing pose, with the neck so stretched and twisted that its under side is uppermost. A Brown Thrasher was also recorded in this posture on May 5, 1954, at 3:00 p.m., after a heavy rain when the sunshine was clear and intense. While remaining fully fluffed, with wings and tail fanned, the thrasher raised its head 6 or 8 times, when alarmed, and then leaned again to turn its head over completely and continue its sunbath.

The species which have been observed in Voluntary Sun-bathing Position are listed in Table I. Only three species, the Brown Thrasher, Carolina Wren (*Thryothorus ludovicianus*), and House Sparrow, have been seen taking sand-baths in connection with the sun-bathing.

Certain questions arise with reference to the Voluntary Sun-bathing:

1. How can a bird so expose its eye, and then, on turning the head, expose the other eye to the direct rays of the sun, without damage? Is it possible that the eye does absorb some ultra-violet rays when so directly exposed?

2. Does the voluntary exposure of the bird to full sun stimulate the preen gland to manufacture and/or produce oil for dressing the plumage? When a bird is in sun-bathing position with its back to the sun, the feathers at the rump are raised so high that they fully expose the naked preen gland.

3. Do continuous days without sun deprive a bird of necessary irradiation, especially in the case of young birds just recently out of the nest? Does a need of irradiation by the sun's rays explain the deliberate and voluntary exposure to intense heat, such as indicated by a reading of 140° F. on the compost leaf pile?

4. Do the external parasites to which birds are the hosts increase in numbers in damp, cool weather, making exposure to intense solar radiation more necessary following periods of cloudy weather?

Compulsory Responses to the Sun

In January, 1954, at my home in Gainesville, Florida, I replaced an old bread tin, which had served as a window feeder, with a brown masonite tray measuring 18 by 22 inches. The window faced due south and for about

Table 1

Species Observed in Voluntary Sun-bathing Position

Green Heron (*Butorides virescens*)	Brown Thrasher (*Toxostoma rufum*)
Royal Tern (*Thalasseus maximus*)	Robin (*Turdus migratorius*)
Mourning Dove (*Zenaidura macroura*)	Starling (*Sturnus vulgaris*)
Ground Dove (*Columbigallina passerina*)	Red-eyed Vireo (*Vireo olivaceus*)
Flicker (*Colaptes auratus*)	Yellow Warbler (*Dendroica petechia*)
Red-bellied Woodpecker (*Centurus carolinus*)	Myrtle Warbler (*Dendroica coronata*)
Golden-fronted Woodpecker (*Centurus aurifrons*)	American Redstart (*Setophaga ruticilla*)
Crested Flycatcher (*Myiarchus crinitus*)	House Sparrow (*Passer domesticus*)
Wood Pewee (*Contopus virens*)	Summer Tanager (*Piranga rubra*)
Blue Jay (*Cyanocitta cristata*)	Cardinal (*Richmondena cardinalis*)
Tufted Titmouse (*Parus bicolor*)	Common Goldfinch (*Spinus tristis*)
Carolina Wren (*Thryothorus ludovicianus*)	White-eyed Towhee (*Pipilo erythrophthalmus*)
Mockingbird (*Mimus polyglottos*)	White-throated Sparrow (*Zonotrichia albicollis*)
Catbird (*Dumetella carolinensis*)	

four hours during the day this tray was exposed to the sun's rays continuously. Birds had fed at this tray from dawn until dusk each day throughout the winter, as well as at the eight other feeders in the yard, all of which were in full or partial shade.

On March 25, 1954, a Myrtle Warbler (*Dendroica coronata*) alighted on the window feeder. It fluffed out all its head and body feathers, fanned its wings and tail and, leaning its head far to one side, appeared briefly to be in a coma. There was an accidental quality about the assumption of the posture which I had not previously noticed in birds which sun-bathed, since it began and proceeded quickly to its climax even as the bird was reaching for food.

In the next three weeks, a period of exceptionally warm weather, my records showed more sun-bathing incidents than in the preceding three years, all but three taking place on or near the feeding tray. The repetition of incidents, combined with what appeared to be an involuntary compulsion to fall into sun-bathing position (in which the birds appeared often to be in obvious discomfort), suggested that it was the compelling force of the sun which brought on this reaction. Furthermore, this sun-bathing was not observed on the tray earlier than 9:30 a.m., (a Myrtle Warbler), nor later than 1:45 p.m., (an Orange-crowned Warbler, *Vermivora celata*). The intervening hours corresponded with the period during which the window feeder was in direct sunlight.

Early records seemed to indicate that the birds suffered from some form of "heat prostration" because of the immediacy of the reaction to the sun

(often within 30 seconds of landing on the tray) as well as the apparent discomfort of the bird. However, continued observation suggests that the Compulsory Sun Position may be a means of regulating the body temperature when the individual is suddenly exposed to the sun. Frequently the bird continues to manipulate a seed in its bill while its feathers are fully fluffed and the bird is leaning far to one side. With some birds, the response alternately is accentuated and subsides many times during the feeding period and before the bird flies to a shady spot; always the bird remains alert to any outside alarm and is able to fly away instantly.

The wild birds recorded in the following pages were under no controls except their own interest in the food always available at the feeding locations.

Several levels of response to the effect of the sun have been distinguished, and are enumerated as follows:

I. The crown feathers are elevated, the wings are dropped so that the tips of the feathers touch the ground, and the tail feathers are spread; then the bird flies away.

II. The crown is elevated, wings dropped, tail feathers spread and the body plumage is fluffed fully before bird leaves.

III. The crown is elevated, wings dropped, tail fanned, body plumage fluffed fully and the bird leans to one side and settles, with bill opened, and eyes open, the upper eye staring at the sun. This response may last from 15 seconds to two minutes or more, depending, in most cases, on outside influences. At no time has any bird become unconscious; all were alert and able to fly away at any alarm.

Position III may be alternated with a return to normal behavior during which the bird preens, scratches and feeds briefly and resumes Level III for as many as six or eight times before flying to shade.

IV. Exaggerated Sun Position—when the bird's wings flopped forward wildly and it gasped, as if for air, and fell flat and widespread on the tray or lawn. This posture was observed most often in young birds, notably in young Jays. Note: In the case of two adult Starlings (*Sturnus vulgaris*), the "lean" was forward, with neck arched and the bill touching the ground, both wings fanned and thrust far forward.

In May, 1954, I put a Taylor candy thermometer, which registers to 300° F., flat on the tray and took the readings recorded in some of the incidents which follow. I recognize the inaccuracy of the readings, which probably include the heat of the sun, air, tray, and reflected heat of the white brick wall, but I include these figures for their possible interest in comparison, and because they seem to indicate that heat, alone, is not the motivating factor. The birds recorded included Cardinals, Blue Jays, Brown Thrashers and Red-bellied Woodpeckers.

Degrees Fahrenheit	Level of Response		
	II	III	IV
105°—109°	3	1	–
110°—114°	3	4	1
115°—119°	13	5	1
120°—124°	3	3	1
125°—129°	–	7	–
130°—134°	15	5	2
135°—139°	7	2	1

A further indication that heat is not the primary factor lies in the realization that air temperatures as low as 55° F. and 60° F. did not preclude a response from some species, all of which are migratory: Myrtle Warbler, Slate-colored Junco (*Junco hyemalis*), White-throated Sparrow (*Zonotrichia albicollis*), and Purple Finch (*Carpodacus purpureus*).

Cloudless, humid days of still air and intense sun resulted in the greatest number of individual responses.

Responses of Permanent Resident Species

On April 12, 1954, at 10:55 a.m., at Gainesville, Florida, a female Cardinal flew to the tray and was visibly affected by the sun's rays as she fed. The crest was raised high, the body feathers fluffed out and the bill opened as the bird breathed heavily. The Cardinal jerked its body as a Myrtle Warbler perched briefly on the tray but remained in Level III. Other Myrtle Warblers, flying toward the tray, swerved away and flew to a nearby shrub. After two minutes, the Cardinal recovered and fed and flew off on the arrival of a male Cardinal.

Both male and female Cardinals, visiting during the sunny hours, were frequently affected in this manner, and before long most of them were confining their trips to the period when the tray was in shade. To those that did visit it in the sun, tray temperatures of 130° F. and above usually brought response II or III, except in the case of a female which was wet from a recent bath and did not respond at all.

On June 18, 1954, at 11:15 a.m., with the tray temperature 112° F., a female Cardinal gave me a further indication that the rays of the sun, rather than heat alone, caused the response. It was a very hot day, with intermittent breezes and clouds. The bird landed on the tray when the sun was behind a cloud and began to feed on sunflower seeds. Suddenly the sun came out, sharp and clear, and the bird went into Level III, still working the seed in its bill. The Cardinal appeared aware of a House Sparrow and a Blue Jay which landed on the tray, but it stayed leaning to one side with its plumage fully fluffed manipulating the seed. A cloud covered the sun and the bird resumed its normal sleekness and moved to the other side of the tray; the sun reappeared and the bird reassumed Level III; another cloud covered

TABLE 2

LEVELS OF RESPONSE OBSERVED IN COMPULSORY SUN-BATHING POSITION

Species	Level I	II	III	IV
Mourning Dove (*Zenaidura macroura*)			x	x
Flicker (*Colaptes auratus*)				x
Red-bellied Woodpecker (*Centurus carolinus*)	x	x		
Blue Jay (*Cyanocitta cristata*)	x	x	x	x
Tufted Titmouse (*Parus bicolor*)		x	x	
Carolina Wren (*Thryothorus ludovicianus*)			x	
Mockingbird (*Mimus polyglottos*)			x	
Catbird (*Dumetella carolinensis*)			x	
Brown Thrasher (*Toxostoma rufum*)		x	x	
Robin (*Turdus migratorius*)			x	x
Starling (*Sturnus vulgaris*)	x		x	x
Orange-crowned Warbler (*Vermivora celata*)		x	x	
Myrtle Warbler (*Dendroica coronata*)	x	x	x	
Ovenbird (*Seiurus aurocapillus*)		x		
House Sparrow (*Passer domesticus*)	x	x	x	x
Bronzed Grackle (*Quiscalus versicolor*)[1]			x	
Cardinal (*Richmondena cardinalis*)	x	x	x	
Purple Finch (*Carpodacus purpureus*)		x		
Common Goldfinch (*Spinus tristis*)			x	
Slate-colored Junco (*Junco hyemalis*)			x	
Chipping Sparrow (*Spizella passerina*)			x	
White-throated Sparrow (*Zonotrichia albicollis*)	x	x	x	

[1]Maine

the sun, and the Cardinal took on its normal appearance and left the tray. Within a minute it was back again, crest erect and body plumage fluffed in the bright sun. A second female Cardinal landed on the tray and both uttered sharp "chick" sounds, as the first bird fluttered its wings, probably in threat, while fully fluffed and leaning, until the second female flew away. The bird continued to manipulate a seed in its bill while in Level III, and flew away when a cloud once again covered the sun, after four full minutes since its first arrival at the tray.

Only one young Cardinal was recorded at the window tray in the sun during the spring and summer of 1954. At the time of its visit the tray temperature was 117° F., and the bird immediately assumed Level III before flying away. It did not return to the tray again during the sunny hours.

A record made on a very hot day in Fayetteville, North Carolina, August 28, 1954, leads me to wonder if the young Cardinals are "taught" the wisdom of avoiding exposure to the sun. At 3:30 p.m., a female and two young flew to the fence and one young bird hopped down to feed at the grain which was on the grass in full sun. The young bird immediately fell into Level III.

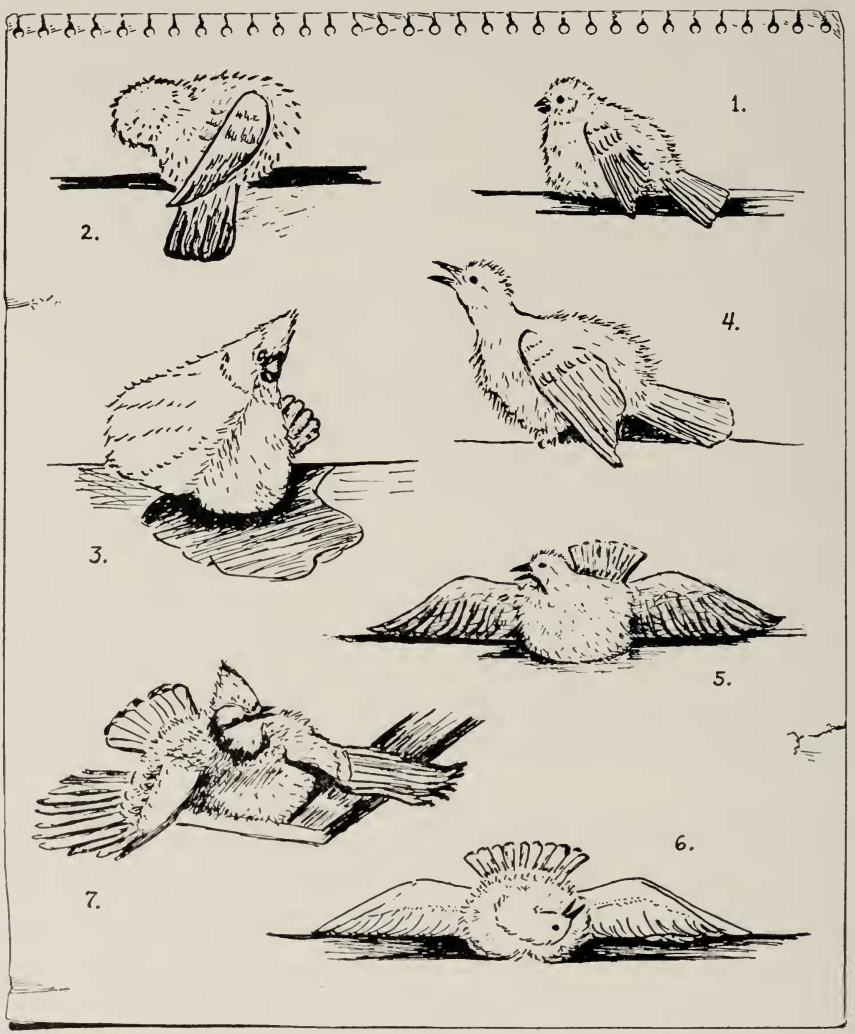

FIG. 1. Sun-bathing postures of some passerine birds sketched by the author. (See text for discussion.) (1) White-throated Sparrow in Level II. (2) Sparrow in Level III, fully fluffed plumage and horizontal lean. (3) Cardinal in Level III. (4) Catbird in Level III. Notice likeness to threat display and courtship display. (5) Mockingbird in Level IV. (6) Mockingbird in Level IV with neck elongated and head turned upside down. (7) Young Blue Jay, in complete collapse on window tray.

A male Cardinal flew in at full speed and, diving down at the young one, chased it up into a tree. Then the male, female and two young birds flew down together and fed in the shade.

Blue Jays began to respond to the sun on the window tray in mid-April, 1954, two weeks later in the season than did the Cardinals, and soon were making their visits so quickly that they often did not land at all, but grabbed a piece of bread while on the wing. One jay, distinctive because of a heavy face molt, was particularly prone to succumb to Level III, although this bird, like the female Cardinal mentioned above, was unaffected when wet from a bath, at a tray temperature of 134° F.

The young Blue Jays did not seem to learn to avoid the tray during the sunny hours, although they were often the most powerfully affected. With wings fanned to the utmost and flapping forward in slow motion, the jays opened their bills and appeared to be both reaching and gasping for air as their body feathers fluffed out and the birds settled flat onto the tray, as though in a state of collapse.

It was not until August 1, 1954, that the Red-bellied Woodpeckers gave any indication of a response to the sun although the males visited the tray daily throughout the summer at all hours. The females had ceased coming to the window in early spring. The response of the young birds was greater than that of the adults. In both, the crown feathers rose first and more fully on the right side, the belly feathers fluffed out, and the right wing was thrown forward flat onto the tray. The birds always left immediately after the wing was thrust forward.

Summer Tanagers (*Piranga rubra*), which are summer residents of the Gainesville area, and Ground Doves, permanent residents, although present on the tray at the same moments as other species mentioned above, appeared never compelled to make any response at all to the sun.

No permanent resident was seen in Compulsory Sun Position in Fayetteville from August 28, 1954, until April 4, 1955, when a female Cardinal assumed Level III at 1:15 p.m., while feeding on the lawn with an air temperature of 67° F.

Responses of Winter Resident Species

The Myrtle Warbler described in the earlier section of this paper was not the last member of the Parulidae to be affected by the sun. By noon of April 12, 1954, I had obtained a fourth record of Myrtle Warblers, including one male in full nuptial plumage, and then they ceased feeding at the tray and fed only at the shaded feeders. All the Myrtle Warblers recorded were affected immediately on landing on the edge of the tray, or as they reached forward for food.

On April 12, 1954, an Orange-crowned Warbler came to the tray twice, at 10:50 a.m. and at 11:55 a.m. On the first visit it fluffed its feathers fully and leaned in Level III immediately, and remained so for a full minute. On the second visit, the bird flew off quickly when its body plumage fluffed and

tail fanned, Level II.

Throughout the rest of that day and the next, this warbler fed only in the shade. On April 14, at 1:45 p.m., it came to the window tray. The crown feathers were raised, the tail fanned, body feathers fluffed out; then the bird flew quickly back to a shrub, two feet away. Its perch here, too, was in full sun, and with its bill wide open and all feathers fluffed out, leaning to the left and, apparently unable to recover, the bird dropped and spread its wings and tail widely. The sun went under a cloud and the bird depressed its feathers, preened briefly and flew to the plum tree where it fed at a suet cup in the shade. This warbler and the few remaining Myrtle Warblers did not visit the window tray again before leaving for the north.

Does this failure to continue feeding at a tray which these warblers had visited daily for several months indicate that they "learned" how they would be affected, and did not want to repeat the experience? Kendeigh (1934:336) says, with reference to temperature tolerances of birds in winter that "A heavy coat of feathers and a thick layer of fat, while serving for better protection of birds in the winter against low air temperature, are at the same time detrimental at extremely high air temperatures because they diminish the radiation of excess heat from the general body surface."

On November 18, 1954, White-throated Sparrows were feeding with House Sparrows at the poultry grain on the lawn. At 12:40 p.m., with an air temperature of 72° F., the sun suddenly came out sharply after three days of rains. Some of the sparrows of both species fluffed their feathers and leaned far to one side as the sun came out. The White-throated Sparrows reacted individually in several different ways (Fig. 1). The first response was always the drop of wings, as described in Level I, while the birds continued to feed: then the belly feathers fluffed out very fully, the crown feathers were raised and the birds leaned far over in Level III. Suddenly a bird would scratch its head violently and resume the fluff and lean. In some cases the bird flew to shade on recovery; in some cases it continued feeding while fluffed. Succeeding days of the same air temperature, with no further rain, brought no such response although the birds fed in full sun.

White-throated Sparrows again responded to the sun from the close of February, 1955, until they left in early May, in air temperatures as low as 55° F. Some of them remained fluffed, in Level III, for as long as three minutes. Many individuals would assume Level III and then subside to preen briefly and feed as many as six or eight times before flying to shade.

This repetition of Level III suggests that there may be sufficient dissipation of body heat after each assumption of the sun-bathing position for the bird to feed again briefly before the rays from the sun once again made it respond.

Discussion

The foregoing records appear to give evidence of what may be an involuntary, compulsory response to the sun on the part of many species of birds. Of primary interest is whether sudden excessive heat is the factor which produces the fluffing of body feathers, crest elevation and fanning of wing and tail feathers at the time of exposure to the sun.

Brown and Davies (1949:92–93) report some observations of the Reed-warbler (*Acrocephalus scirpaceus*):

". . . In sunny weather a few of the nests built on the fringe of the reeds are exposed, usually for short periods of the day only, to full sunshine. Under these conditions the hen bird will shade the chicks by standing in the nest and half opening her wings so that the cup is completely covered. In really hot weather it soon becomes apparent that the hen herself is being severely affected by the heat. The first indication of this distress is a mild form of "panting" with mandibles slightly open, but after a short while the panting increases and the mandibles are open to an angle of as much as thirty or forty degrees. Should a bird in this state continue to shade the chicks, she will suddenly collapse in a most extraordinary manner, lurching over on one side, sometimes closing her eyes and certainly giving the impression that she is on the point of expiring. She then raises the wing on the free side of her body and extends it vertically above her to its fullest extent, the primary feathers standing out like fingers. She maintains this rigid attitude for several minutes, during which she gradually opens her eyes and virtually stops panting. Quite suddenly she closes the wing and stands up in the nest as if nothing had happened and will then either continue to shade the chicks or go off in search of food. In the hot summer of 1947 this curious piece of behavior, which we then believed to be completely original for the species, was witnessed on four or five occasions and two observers were fortunate enough to get photographs, one of the initial stage of collapse, and the other of the bird with the free wing rigidly extended. Quite clearly the stretching up of the wing has beneficial effect upon the distressed bird and it may well be that this serves to expose the sub-clavian vein to the air, thus resulting in direct cooling of the blood."

The response of these nesting Reed-warblers to the sun appears to parallel my own observations closely. The implications of this apparently compulsory response to the sun's rays prompt questions which can only be answered by scientific study.

Are the feathers fluffed in order to expose as much as possible of the outer skin surfaces to the air, to better combat the excessive body temperature? This would be in direct contradiction to the statements of men who had studied the effects of artificially induced heat in birds. Dawson (1954:115) states that "Birds decrease the effectiveness of their insulation by compressing their feathers. They also expose the thinly feathered sides of the thorax by holding their wings away from the body." Likewise, Wallace (1955:40) states: ". . . in warm weather, the feathers are often depressed or held close to the body to allow some escape of body heat."

The response to high temperatures discussed by these authors holds true of birds in shady locations on extremely hot days, as well as in artificially-

controlled cages, but exposure to direct sun appears to evoke an entirely different response that I have called Compulsory Sun Position.

Is this reaction a physiological response generated by the bird's heat-dissipating mechanism? Alternation of Level III with normal composure, described earlier, was a commonplace incident in the case of the White-throated Sparrows on many different days, suggesting that there was sufficient dissipation of body heat after each assumption of the sun-bathing position for the bird to recover and feed until the sun again forced the bird into Level III.

Humidity appears to play a more important part than high air temperatures in the responses that I have recorded. The condition of the individual bird, whether breeding, molting or migrating, appears also to have its effect.

The colors of the birds recorded include almost every shade including iridescent black, a circumstance which would indicate that pigment, or lack of it, was not a determining factor. The only species, feeding when these records were made, which were never seen in Compulsory Sun Position were the Ground Dove, Summer Tanager and Fox Sparrow (*Passerella iliaca*).

The sun plays a vital part in the life-cycle of birds as it does for every living thing. It is hoped that this paper will draw attention to the subject and that observation and study of the effect of the sun on birds will follow.

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